Pulling G's in CAP

By Joe Macklin, Montana State Director

The sun had set several hours earlier, and there we were . . . three generations of eager pilots, two of whom had flown B-24 and B-25 aircraft back in WWII (Jim Brown and Don Lilienthal), two who had learned to fly in the 70's and 80's (Joe Macklin and Jan Van Hoven), and our newest addition, Doris Van Hoven, who soloed out in December 2005, all waiting somewhat impatiently in the lounge area of Holman Aviation at the Great Falls International Airport for the arrival of Civil Air Patrol's newest and most technologically advanced aircraft ever . . . the Cessna 182T Nav III Glass Cockpit. You heard correctly . . . **GLASS COCKPIT!!!**

On a crisp Sunday morning in January 2006, Lt Col Tom Connor and Capt Sage Olson lifted off from Independence, Kansas in a brand new Cessna 182T model aircraft with only 25 hours on the airframe. The aircraft they had chosen, tail number N702CP, was the newest addition to a Civil Air Patrol fleet of over 550 aircraft. This bird sported a Textron-Lycoming IO-540 powerplant – a fuel-injected, six-cylinder, horizontally opposed direct drive engine of 540 cubic inch displacement. The "I" in "IO" stands for fuel injected and the "O" stands for opposed cylinders.

Tom and Sage had just completed the most intensive one-week smash course of flight training and instructor certification known to general aviation, and were now delivering their proud bird to their home state of Montana. Tom and Sage had been hand selected to attend a highly competitive FAA approved Industry Training Standard (FITS) glass cockpit course offered by Cessna and financed by the U.S. Air Force. Not only had they "mastered" the art of playing with a fancy new computer display as they slipped through the air at 140 KIAS, but they had to be able to instruct and impart this vast new computer knowledge onto unsuspecting young and old craniums alike once back home.

At the same time Tom and Sage were burning the midnight oil in Independence, Kansas, our very own State Director, Joe Macklin, was playing catch-up in the same model aircraft at the Air Force "school house" in Springfield, Missouri. The Air Force hosts a traveling team of FITS-certified instructors who circulate around the country upgrading CAP-USAF pilots in the glass cockpit variant. Joe had also been selected to upgrade into the new aircraft and was eager not only to start flying 702CP, but even more so, to swap stories and share flying techniques with Tom and Sage.

So what is all this commotion about this glass cockpit you ask? Well let me tell you, after having flown upside down, leading four-ship formations, and ripping G's in Air Force jets and turpoprops for nearly 30-years, it was about time I started "pulling some G's" in the Civil Air Patrol! Not the kind of G's I used to pull, where your face is nearly yanked off your body at six times the force of gravity, but instead the revolutionary, all-glass integrated flight deck of the G1000. Given that many Civil Air Patrol pilots have never flown behind even a horizontal situation indicator (HSI), the idea of an all-electronic cockpit in a CAP Skylane is revolutionary!

The G1000 refers to a Garmin produced, completely integrated avionics and engine monitoring system designed to fit a broad range of aircraft models. It's a fully computerized or "glass" flight deck that presents flight instrumentation, terrain, Jeppesen approaches and maps, navigation, communication, and engine data on large-format, high-resolution digital displays. The G1000 puts all flight-critical information literally at the pilot's fingertips.

According to AOPA magazine, Garmin founders Gary Burrell and Min Kao (the *Gar* and *Min* in *Garmin*) had envisioned the G1000 since before they produced their first product in 1989. From the beginning, Garmin planned for their GPS navigation components to grow into an integrated cockpit system. Now, with thousands of Garmin units delivered and many thousands of hours of flight time, these components bring a level of unsurpassed maturity to the new G1000 flight deck. [1]

Cessna Aircraft Corporation, as innovative in its own right as Garmin, jumped at the chance to be one of the first to offer this new technology to Civil Air Patrol pilots. I remember visiting a G1000 display at a summer National Board several years ago and wondered if all of this "gee whiz" computerized avionics would ever really happen to CAP. I was skeptical to say the least. Well, a couple of years later and my dreams of flying 'glass' once more have now turned into REALITY!

Let me tell you a little bit about this new Imax-theater-like display we affectionately call the "glass cockpit"!

Cockpit Display of Cessna 182T "Glass Cockpit"

Our newest Cessna comes with two 10.4-inch liquid crystal displays with XGA-quality, 1,024 by 768 pixels, a high performance graphic accelerator, 16 million colors and extremely wide viewing angles. The displays are mounted into the instrument panel, with the primary flight display, or PFD, on the left hand side and the multi function display, or MFD, on the right. Both displays work hand-in-hand to provide the pilot with a host of information at the touch of a button. In addition to the two displays, there are two integrated audio panels mounted horizontally, one for each crewmember in the front seat. A voice synthesizer (Betty or Bob – your choice) alerts the pilot to system anomalies and, depending on the way you set up the cockpit, can warn of traffic alerts, minimum altitudes, and other important messages.

The flight displays are only 2 inches deep and weigh about 6.5 pounds each. Think of the PFD as replacing the conventional six-pack of instruments (heading, altitude, airspeed, compass, attitude, turn & slip) and more. Besides showing attitude and an HSI, the screen also depicts airspeed in a tape format with trend lines showing where you will be in six seconds. Similarly, altitude and vertical speed are shown by way of tapes down the right side of the screen, also with trend lines.

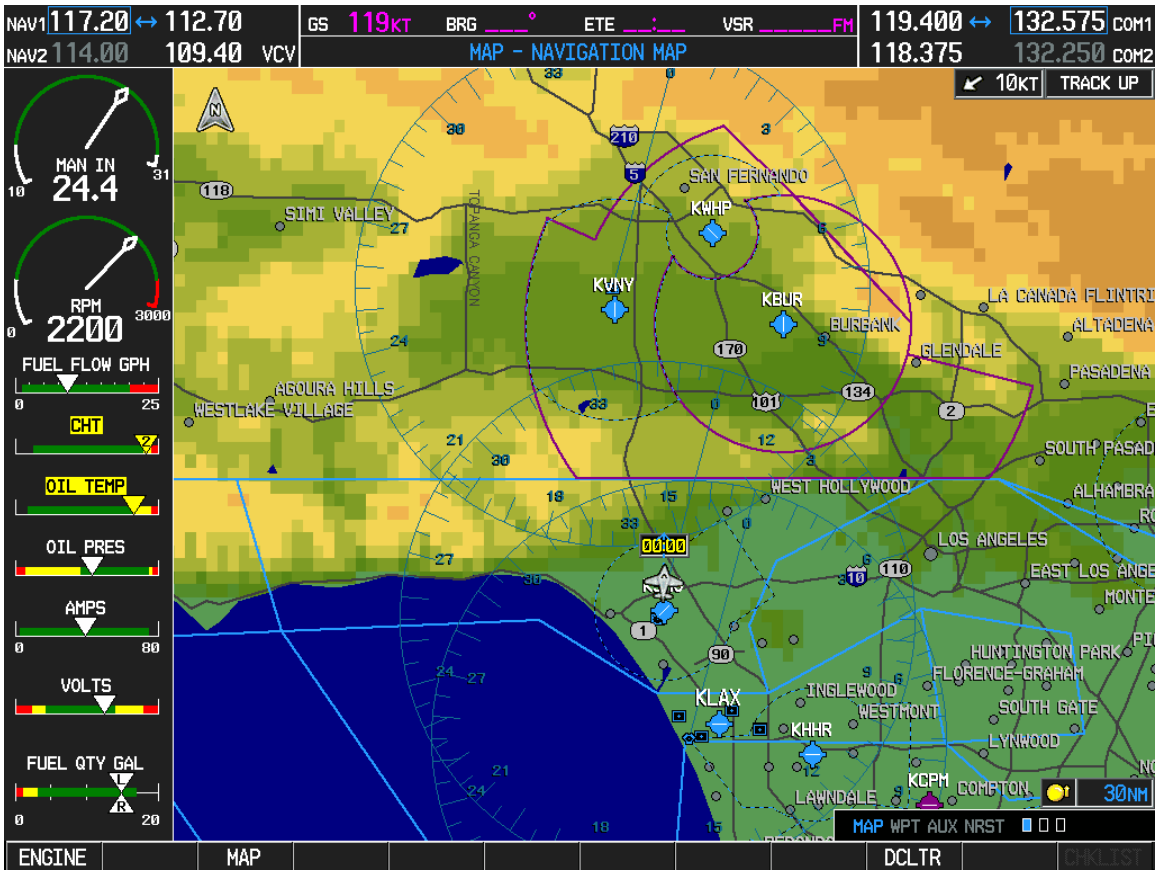
Every aspect of the G1000 shares critical information with every other component through an Ethernet cable. Ethernet is the same lightning-speed computer wire that allows the instantaneous bi-directional flow of information that we see common with our home and business computers. A config.sys file in the airplane tells the display that it's intended for a Skylane and voilá; it's ready to go.

The pilot can elect to display a small moving map on the lower left of the PFD and a window showing flight-plan waypoints on the right. Across the extreme top are a number of pilot-configurable windows that depict typical GPS information, such as next waypoint, time, distance, and desired track. I noticed if your seat

is raised to the upper limit, it's easy to miss the GPS info on the PFD because of the position of the glare shield, so be mindful when adjusting the left seat. In the upper left are the VHF navigation frequencies and control knobs. Below that is a heading bug knob; a push syncs the bug to the current heading – a great feature when using the autopilot. Further below that is the altitude knob for setting altitude bugs.

Primary Flight Display or "PFD"

Now lets move to the upper right of the PFD where the communications frequencies and their control knobs lie. Below the com control knob is the control for setting barometric pressure and the course indicator for instrument approaches. Next is a tiny joystick for moving the cursor around the small moving map. Below that is a series of buttons familiar to Garmin users for setting up flight plans, instrument approaches, and other day-to-day navigation chores. A flight management system (FMS) knob works in tandem with the nav keys. Ten soft keys across the bottom do a variety of things for the pilot, from bringing up the transponder functions, to clearing cautions and warnings, to configuring the PFD. They are called *soft keys* not because they feel soft, but because their functions are not hard-wired, but are software based. In other words, the keys perform different functions depending on what you want them to do. When a soft key is depressed, drop-down menu choices appear and the other soft keys pick up new functions. A handy *back* button is available to back out of the menus, and if all else fails, there's a "get out of jail" button that when depressed for one-second, cleans up your screen to its original settings.



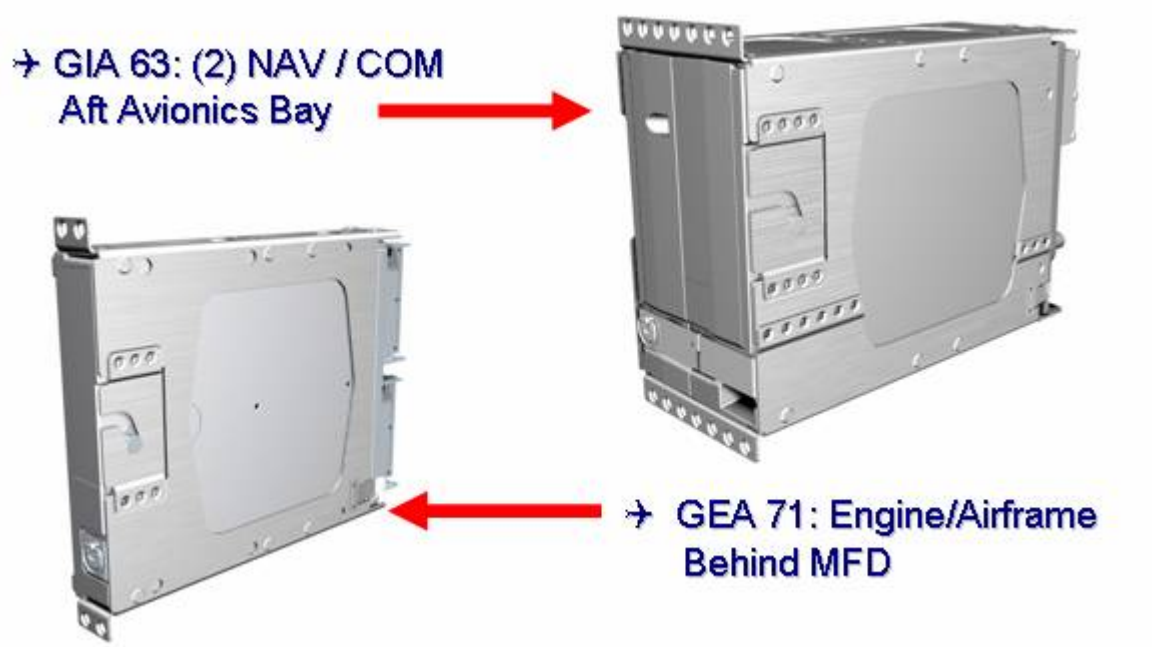
Multi Function Display or "MFD"

And that's just an overview of the pilot's display. Now let's move across the cockpit to the really fun multi function display (MFD). The MFD looks surprisingly familiar because it is exactly the same display as the PFD – same buttons, same labels. In fact, the two displays can literally be swapped out. You can even use knobs on the MFD to perform functions on the PFD and vice versa. A change to a com frequency on one display, for example, is automatically repeated on the other display – again, thanks to the Ethernet bus that allows every component to talk to every other component. The MFD is where you can get creative with the setup. You can set the moving map any way you want by turning features on or off – such as terrain avoidance, obstructions, transponder mode C and S to view traffic in terminal areas, airspace deconfliction, airports, navaids, color radar (via NEXRAD data link), storm scope, and lots, lots more. And the map display is HUGE – it literally fills up most of the 10.4-inch display which makes navigating a synch even for optically challenged pilots like myself. And for those long cross-country hauls, The G1000 uses an XM Satellite Radio-delivered datalink that includes a host of weather products in the cockpit and 101 channels of satellite entertainment.

Bendix/King KAP 140 Two-Axis Autopilot with Altitude Preselect

Garmin is also developing a flight control system that will be integrated into the G1000. But since that component won't be available until later this year, Cessna has installed the Bendix/King KAP 140 two-axis autopilot instead. I found the autopilot to be the biggest challenge and trickiest aspect of deftly operating this aircraft. Unlike the rest of the G1000 components, the flight control system is not yet fully integrated. On more

than one occasion, I found myself flying right through localizer final, or glidepath on an ILS, and having to disconnect the autopilot because it was "not talking to" the rest of the G1000. This is definitely a "gotcha" we're going to need to keep a close watch on, especially when flying in the soup!



Typical Line Replaceable Units or "LRUs"

Behind the computerized flight displays are two maintenance racks containing several line replaceable units, or LRUs, that house the brains of the G1000. Each LRU is a self-contained, solid-state component with a modular design, which greatly eases troubleshooting and maintenance. If any single component fails, it's a simple thing to pull out the affected LRU and replace it with a new one. The term "line replaceable unit" literally means that it can be replaced with the aircraft still on the line, without taking it out of service. And with such a new system, our LRUs are all under factory warranty.

The Engine Display Unit (EDU) replaces the standard "round dials" and accurately depicts all of the engine data very clearly and with precise measurements on the left side of the MFD. Among the presentations are: manifold pressure; tachometer; cylinder head temperature; exhaust gas temperature; fuel flow and quantity; oil temperature and pressure; amps; and voltage. If any item exceeds established parameters, the G1000 alerts the pilot. A touch of the engine soft key brings up a larger display that shows cylinder head and exhaust gas temperatures for each cylinder and allows for managing fuel inputs. There's also a slick system to assist in leaning to exactly 50° rich of peak EGT. What happens if an engine component fails or the entire EDU drops off line? Well, no need to sweat. Fault monitoring in the G1000 tracks any problems and promptly alerts maintenance crews. In flight, the system uses master warning and caution lights to tip off the crew to problems.

The heart of the G1000 belongs to two independent attitude and heading reference systems or AHRS (pronounced āhărs). AHRS is basically a solid-state gyro replacing the precession-prone conventional spinning gyros we've become used to. And who said that maintenance on the G1000 would be more expensive compared to older Cessnas? Well the mean-time failure rate for solid-state AHRS is nearly 10,000 hours – compared to about 500 to 1,000 hours for conventional gyros!

According to AOPA, Garmin recognized that it would take four to five years to develop its own AHRS, so in 2001 Garmin went shopping for technology and found Sequoia

Instruments.[2] Sequoia uses 3-D GPS, magnetometry (measurement of changes in the earth's magnetic field), and air data information to precisely compute the aircraft's attitude. Any one of these components can accurately determine the aircraft's attitude, so if one or two inputs fail, the system marches on seamlessly to the pilot.

And the aircraft does not have to remain still for three minutes during startup to configure itself like many of the other systems showing up in light airplanes today. The G1000 can figure out where and what it's doing in almost any bank or pitch angle. According to Bill Stone, Garmin's avionics product manager, the G1000 can be shut down for 45 seconds while in flight and it won't loose its accuracy.[3] I doubt most airliners and business jets can do that! Not that I want to try this out in the weather; it could certainly be a very long 45 seconds for sure!

In case one of the large computer displays fails, the system automatically reverts to the other display, providing the pilot with everything needed to safely fly. And if both displays were to fail, or if you happened to loose all electronics, well there are three standard standby instruments in clear view from both crew positions to safely land with.

Phewwww – Haven't we had enough already?!?!?!? Sorry, I easily get carried away with the "gee-whiz" aspects of this new, slick aircraft. So, what's the bottom line? Well, this Air Force pilot thinks this new aircraft is perfect for the expanded homeland security role the Air Force auxiliary is finding itself embracing. Viper or Eagle intercepts will now be depicted on your MFD before the fighter is within visual range of its unsuspecting target (you). Low-level flying in the mountains will be a synch with color-coded terrain to depict 1000 foot and 100 foot obstacles. ELT searches will be even easier with the combined Becker and G1000 systems. Aerial photography is near real-time with the advent of state-of-the-art Satellite Digital Imaging System (SDIS). And it's now virtually impossible to get lost or disoriented day or night.

So, what are the drawbacks? Well, there are clearly going to be some challenges for all of us. The learning curve to operate this new machine is extremely steep. And retaining the knowledge is going to be even more challenging. There are always bugs to work out, especially when we're talking flying with a full crew and operating multiple radios. Flight currency will be critical. And my biggest concern is flying solo with all the bells and whistles available in the aircraft – exactly who will be looking outside? The same goes when you have two pilots, or a pilot and observer flying. It will be very tempting to go "heads down" for long periods of time, and forget to look outside to "see and avoid" for other traffic.

But all in all, this is a huge shift to the 21st century for Civil Air Patrol! And speaking for the three generations of pilots who waited expectantly for two hours in the Holman Aviation lounge that Sunday evening, this is a dream come true! It really doesn't matter how old your are, how much experience you have, or what your crew position you fill; you're going to be impressed with the Cessna 182T Nav III Glass Cockpit.

Welcome to the new world of pulling "G's" in CAP – the **G1000**.

Endnotes

[1, 2, 3] Thomas B. Haines, "Diamond DA40-180, the Gee Meter", January 2004 issue of AOPA Pilot Magazine.